Revista Colombiana de Nefrología
Vol. 13, Núm. 2 (2026) - Publicación continua
http://doi.org/10.22265/acnef.13.2.1008

Original article

Indirect costs and out-of-pocket expenses in chronic kidney disease on dialysis

Camilo A González[1,2], Maria Camila Echeverria[3], Carolina Forero[3], Kateir Contreras[2,3], Ana María Arana[1], Erica Yama[1], Diana Vargas[1,2], and Darío Londoño[4]

[1]Nephrology Unit, Clínica Colsanitas, Bogotá, D.C., Colombia
[2]Hospital Universitario San Ignacio, Bogotá, D.C., Colombia
[3]Pontificia Universidad Javeriana, Bogotá, D.C., Colombia
[4]Fundación Santa Fe de Bogotá, Bogotá, D.C., Colombia

How to cite: González CA, Echeverria MC, Forero C, Contreras K, Arana AM, Yama E, et al. Indirect costs and out-of-pocket expenses in chronic kidney disease on dialysis. Rev. Colomb. Nefrol. 2026; **13**(2), **e1008**. https://doi.org/10.22265/acnef.13.2.1008

Submitted:
24/Apr/2025
Accepted:
15/Sep/2025
Published:
22/Jun/2026

Abstract

Background: Cost analysis studies of chronic kidney disease (CKD) have primarily focused on direct costs. Peritoneal dialysis (PD) is more cost-effective than hemodialysis (HD); however, the time spent by patients and caregivers on treatment is usually not considered.

Objective: To estimate the indirect costs and out-of-pocket expenses associated with chronic kidney disease on peritoneal dialysis compared to hemodialysis in Bogotá, Colombia.

Methods: A cost analysis study was conducted. Out-of-pocket expenses were estimated by the weighted average of monthly events per reported dialysis-related expenditure. Indirect costs were estimated on a monthly basis, taking into account transportation time, dialysis procedure time, and perceived patient and caregiver disability. Univariate and multivariate analyses were performed to compare costs between peritoneal dialysis and hemodialysis. Estimated values in Colombia were shown per minimum wage (MW) in 2023. A significance level of $p < 0.05$ was considered.

Keywords: Health expenditures, Dialysis, Hemodialysis units, Hospital, Peritoneal dialysis.

Correspondence: Camilo A González, Calle 127 No 20-78 Piso 2 Bogotá. D.C., Colombia. E-mail: camiloalbgonzalez@colsanitas.com

E-ISSN: 2500-5006/L-ISSN: 2389-7708

Results: We included 132 patients, 40 on PD and 92 on HD, with a median age of 61 years (IQR: 43.7-72.25), of which 43.9 % were female. Patients on PD reported being more occupationally active than those on HD (p = 0.028). Catastrophic expenditure was reported by 28.2 % of the cohort. The median out-of-pocket expense was 0.41 MW, USD 112.3 (IQR 55.2-200.1), per month, with no differences between therapies (p = 0.17). Indirect costs were higher among patients receiving HD, at 1.64 MW and USD 447.2 (IQR 201.3-766.2), compared to those receiving PD, at 0.56 MW and USD 153.3 (IQR 46.8-511.1) (adjusted p = 0.0002).
Conclusion: Catastrophic expenditure was reported by 28.2 % of the cohort. Indirect costs were higher in HD compared to PD. A larger sample size is required to identify differences in out-of-pocket expenses and between different modalities of PD.

Costos indirectos y gastos de bolsillo en enfermedad renal crónica en diálisis

Resumen

Antecedentes: los estudios de análisis de costos en enfermedad renal crónica (ERC) se han centrado principalmente en los costos directos. La diálisis peritoneal (DP) ha demostrado ser más costo-efectiva que la hemodiálisis (HD); sin embargo, el impacto del tiempo dedicado al tratamiento por parte del paciente y del cuidador no suele incluirse en estos análisis.
Objetivo: estimar los costos indirectos y los gastos de bolsillo asociados con la enfermedad renal crónica en pacientes en diálisis peritoneal, en comparación con aquellos en hemodiálisis, en Bogotá, Colombia.
Métodos: se realizó un estudio de análisis de costos. Los gastos de bolsillo se estimaron mediante el promedio ponderado de eventos mensuales por cada gasto relacionado con la diálisis reportado. Los costos indirectos se calcularon mensualmente, considerando el tiempo de transporte, el tiempo dedicado al procedimiento dialítico y la discapacidad percibida por el paciente y el cuidador. Se realizaron análisis univariados y multivariados para comparar los costos entre diálisis peritoneal y hemodiálisis. Los valores estimados para Colombia se expresaron en salarios mínimos mensuales legales vigentes (SMMLV) de 2023. Se consideró un nivel de significancia de p <0,05.
Resultados: se incluyeron 132 pacientes, 40 en DP y 92 en HD, con una mediana de edad de 61 años (RIC: 43,7–72,25), de los cuales el 43,9 % eran mujeres. Los pacientes en DP reportaron una mayor actividad ocupacional en comparación con aquellos en HD (p = 0,028). El 28,2 % de la cohorte reportó un gasto catastrófico. La mediana del gasto de bolsillo fue de 0,41 SMMLV, equivalente a USD 112,3 (RIC: 55,2–200,1) por mes, sin diferencias significativas entre las modalidades de diálisis (p = 0,17). Los costos indirectos fueron mayores en HD, con 1,64 SMMLV, equivalentes a USD 447,2 (RIC: 201,3–766,2), en comparación con DP, con 0,56 SMMLV, equivalentes a USD 153,3 (RIC: 46,8–511,1) (p ajustada = 0,0002).
Conclusión: el 28,2 % de la cohorte reportó un gasto catastrófico. Los costos indirectos fueron mayores en los pacientes en HD en comparación con aquellos en DP. Se requiere un tamaño de muestra mayor para identificar diferencias en los gastos de bolsillo y entre los diferentes tipos de DP.

Palabras clave: gasto en salud, diálisis, unidades de hemodiálisis hospitalarias, hospital, diálisis peritoneal.

Background

Chronic kidney disease (CKD) is a public health problem with a prevalence of up to 13 % worldwide [1]. In Colombia, 864.5 individuals per million population receive renal replacement therapy (RRT) for CKD, with 58 % on hemodialysis, 21 % on peritoneal dialysis, and 17 % having received a kidney transplant [2]. Dialysis generates an average direct medical cost of 5,900 United States dollars (USD) per patient annually in Colombia [3].

The direct cost of hemodialysis (HD) is higher than that of peritoneal dialysis (PD), with a difference that decreases with the duration of therapy [4], explaining part of the better cost-effectiveness of PD [5]. Some research indicates a higher indirect cost associated with hemodialysis [6, 7]. Out-of-pocket expenses are the direct payments made by individuals for medical care, excluding costs covered by insurance or other third parties. These include deductibles, copayments, and services not covered by a health plan. Indirect costs, on the other hand, refer to the value of lost productivity due to illness, injury, or death. Examples include lost wages from missing work, reduced productivity while at work and the time spent by family members acting as caregivers. These costs are usually difficult to measure and are therefore uncommonly reported [8, 9].

Chronic Kidney Disease (CKD) requiring dialysis places a heavy financial burden on patients and families. While many countries provide dialysis through public or insurance programs, patients often face out-of-pocket (OOP) expenses for medications, medical supplies, transportation, lodging, and copayments. They also incur substantial indirect costs due to loss of income, caregiver time, missed work, and reduced productivity. Over the past decade, South American nations have expanded coverage for dialysis; however, cost burdens persist, with significant disparities across countries. In most countries, a mix of public and private funding covers the majority of dialysis expenses, leaving patients to pay roughly 1–25 % of total costs [10]. Nevertheless, in lower-resource settings, patient contributions can be much higher—up to 50 % of total dialysis costs in some countries [11]—or patients may forgo treatment entirely due to unaffordability [12].

Knowing the indirect cost and informing patients about it could influence their choice of dialysis modality [7]. Additionally, it allows for cost-effectiveness analysis from both the patient's and societal perspectives. This study aims to estimate and compare the indirect and out-of-pocket expenses of CKD patients on PD compared to HD.

Methods

A cost analysis study with a cross-sectional survey design was conducted, including adults with end-stage renal disease (ESRD) on hemodialysis (HD) or peritoneal dialysis (PD) for at least three months between November 2022 and June 2023 at the Renal Unit at Colsanitas Clinic and San Ignacio University Hospital. Patients with the following conditions were excluded: pregnancy, human immunodeficiency virus (HIV), hepatitis B or C, advanced stage D heart failure, advanced chronic pulmonary disease requiring 24-hour oxygen, dementia with Global Deterioration Scale (GDS) stages 5 and 6, Barthel Index $\leq$ 60 points, active non-skin cancer, or palliative medical treatment intent. Informed consent was obtained for survey participation. This study was approved by the research and ethics committee of San Ignacio University Hospital with approval number 004/2023 in record number 1/2023 and by the Sanitas University Foundation with code CEIFUS 1583-23. Cost analysis experts validated the survey, and a language validation test was conducted with ten patients. Clinical data were extracted from electronic health records. Data were collected in REDCap [13]. Colombia's estimated values were shown per minimum wage (MW) in 2023. The conversion from Colombian pesos (COP) to USD was performed using the average rate for 2022 (one USD = 4,255.44 COP) based on the official report of the Republic Bank of Colombia.

Out-of-pocket expenses

Out-of-pocket expenses are direct payments for health goods and services derived from primary income and household savings. These included transport expenses, contracts for specific services such as physical therapy, nursing, medications, nutritional supplements, biomedical supplies for dialysis, and medical consultations. For patients who reported using a personal vehicle for transportation, the fuel cost was calculated considering the average 2022 gallon price, distance, and average gasoline consumption per urban kilometer traveled [14]. Hospitalization out-of-pocket costs were calculated using the daily cost reported multiplied by the average length of hospital stay (8 days in Colombia) [15]. Monthly out-of-pocket expenses were estimated by the weighted average of monthly events multiplied by the reported cost. The proportion of out-of-pocket expenses relative to income and the proportion of patients with catastrophic expenses, defined as out-of-pocket expenses exceeding 40 % of income, were estimated [16].

Indirect costs

Indirect costs were defined as those related to decreased income due to the time required to manage stage 5 CKD on dialysis. In this study, indirect costs for both patients and their

caregivers were considered. For the patient's indirect costs, we included estimated travel time according to Google Maps, time on dialysis, and the time of disability or when the patient felt unable to perform their daily activities as reported by the patient. For peritoneal dialysis patients, we considered the time required for training, connection procedures, exchanges as needed, regular medical follow-up, and complications related to therapy. The reported weekly hours of patient care needs related to ESRD or dialysis were considered to estimate caregiver time spent. For the time of disability and reduced working hours, a maximum of 210 effective monthly hours was set, corresponding to the legal maximum working hours in Colombia. The monthly reported income was multiplied by the hours spent reported by the patient and caregiver to monetize indirect costs, respectively. Comparative analysis was performed for both reported hours and estimated values.

Statistical analysis

The sample size was calculated to compare indirect costs between therapies using a two-sample t-test, with a power of 90 % and an alpha error of 0.05, considering data from a previous study [17]. A sample size of 33 survey participants per dialysis type was calculated, including an estimated 10 % loss. Sociodemographic and clinical characteristics were reported as proportions, measures of central tendency, and dispersion according to variable distribution and type. Out-of-pocket expenses and indirect costs were estimated as the median and interquartile range (IQR) for each therapy. A multivariate linear regression with a gamma logarithmic distribution was performed for the comparison. A p-value <0.05 was considered statistically significant. Colombia's estimated values were shown per minimum wage (MW) in 2023. The conversion from COP to USD was performed using the average exchange rate for 2022 (1 USD = 4,255.44), based on the official report of the Republic Bank of Colombia. We used RStudio v. 3.3.0 for the analysis.

Results

One hundred and thirty-two patients were surveyed, 40 patients in PD and 92 in HD. Demographic and socioeconomic characteristics are presented in table 1. The median age was 61 years (IQR 43.75-72.25) with no statistically significant differences between groups, and 43.9 % were female. Most of the respondents were in the contributory regime healthcare system (97 %), belonged to the medium socioeconomic stratum (39.4 %), and had a high school education (33.3 %). A total of 41.7 % reported being retired due to disability or old age. No statistically significant differences in comorbidities were found between the dialysis types. Regarding monthly income, the reported values were similar between the groups. Patients on PD reported higher levels of active employment (independent or employed) compared to patients on HD.

Table 1. Demographic and socioeconomic characteristics

Variable	Peritoneal dialysis (n= 40)	Hemodialysis (n= 92)	Total (n=132)	p
Age (years), median (IQR)	55 (41.7-68.5)	61.5 (47.5-74)	61 (43.7-72.25)	0.52
Female, n (%)	18 (45)	40 (43.5)	58 (43.9)	1
Time in dialysis (months), median (IQR)	25.5 (10.4-35.8)	35.2 (18.6-56.7)	32.1 (15.3-54.35)	0.07
Residence in Bogotá, n (%)	31 (77.5)	83 (90)	95 (87 %)	0.04
Dialysis center 1, n (%)	4 (13)	32 (41)	36 (33)	0.007
Contributory regime, n (%)	40 (100)	88 (95.7)	128 (97)	0.43
Marital status, n %				
Single	10 (25)	23 (25)	33 (25)	
Married	22 (55)	41 (44.6)	63 (47.7)	0.36
Widowed	0 (0)	8 (8.7)	8 (6.1)	
Divorced	3 (7.5)	6 (6.5)	9 (6.8)	
Registered partnership	5 (12.5)	14 (15.2)	19 (14.4)	
Social stratification, n %				
1	4 (10)	4 (4.3)	8 (6.1)	0.41
2	8 (20)	21 (22.8)	29 (22)	
3	16 (40)	36 (39.1)	52 (39.4)	
4	4 (10)	21 (22.8)	25 (18.9)	
5	5 (12.5)	7 (7.6)	12 (9.1)	
6	2 (5)	3 (3.3)	5 (3.8)	
Educational level, n %				
Primary	6 (15)	22 (23.9)	28 (21.2)	0.68
Secondary	14 (35)	30 (32.6)	44 (33.3)	
Upper secondary (technical)	6 (15)	12 (13)	18 (13.6)	
Professional	9 (22.9)	23 (25)	32 (24.2)	

Table 1. Demographic and socioeconomic characteristics

Variable	Peritoneal dialysis (n= 40)	Hemodialysis (n= 92)	Total (n=132)	p
Postgraduate	4 (10)	4 (4.3)	8 (6.1)	
Occupation, n %				
Employee	12 (30)	8 (8.7)	20 (15.2)	
Independent	10 (25)	26 (28.3)	36 (27.3)	
Retired	12 (30)	43 (46.7)	55 (41.7)	0.028
None	2 (6.7)	10 (12.7)	12 (11.8)	
Home	1 (2.5)	2 (2.3)	3 (0.8)	
Comorbidity, n %				
Diabetes without complications	4 (10)	22 (23.9)	26 (19.7)	0.1
Diabetes with complications	4 (10)	9 (9.8)	13 (10.1)	1
Arterial hypertension	34 (85)	80 (87)	114 (86.4)	0.98
Heart failure	5 (12.5)	10 (10.9)	15 (11.4)	1
Coronary heart disease	5 (12.5)	15 (16.3)	20 (15.2)	0.76
Cerebrovascular disease	0 (0)	4 (4.3)	4 (3)	0.43
Dementia	1 (2.5)	0 (0)	1 (0.8)	0.66
Chronic lung disease	0 (0)	6 (6.5)	6 (4.5)	0.23
Peripheral arterial disease	0 (0)	1 (1.1)	1 (0.8)	1
Autoimmune disease	4 (10)	8 (8.7)	12 (9.1)	1
Disability, n %				
Disability perception	27 (67.5)	64 (69.6)	91 (68.9)	0.9
Disability retired	6 (15)	17 (18.5)	23 (17.4)	0.57
Disability days/month, median (IQR)	3 (1.5-16.2)	12 (5.7-17)	12 (4-17)	0.002

Table 1. Demographic and socioeconomic characteristics

Variable	Peritoneal dialysis (n= 40)	Hemodialysis (n= 92)	Total (n=132)	p
Adult relatives at home, median (IQR)	1 (1-2)	2 (1-3)	2 (1-3)	0.16
Income MW, median (IQR)*				
Income before dialysis (MW)	2.5 (2-4.25)	3 (2-6)	3 (2-5)	0.53
Income during dialysis (MW)	2 (2-4.5)	3 (2-7)	2 (2-6)	0.14
Other sources of income (MW)	1 (1-1)	1 (1-2)	1 (1-2)	0.15
Family income (MW)	3 (1.7-4.5)	3 (2-4)	3 (2-4)	0.98

IQR: interquartile range; MW: current legal monthly minimum wages.
* Monthly income in current legal monthly minimum wages for 2023.

Source: The authors.

Out-of-pocket expenses

Out-of-pocket expenses are presented in table 2. One patient did not report any out-of-pocket expenses. Concerning transportation-related out-of-pocket expenses, it was evident that 41.7 % of patients used state-provided means of transportation. In these cases, the expenses were monetized as the product of distance and fuel consumption. Patients in the HD and PD groups reported no statistically significant differences in the distance or travel time. Among other expenses, parking and medications were the most frequently reported, with non-significant differences in value between the groups. A catastrophic expenditure was reported by 28.2 % of the cohort. The median out-of-pocket expense was 0.41 MW, USD 112.3 (IQR 55.2 – 200.1) per month, with no differences between therapies (p = 0.17).

Table 2. Out-of-pocket expenditure of the population on peritoneal dialysis and hemodialysis

Variable	Peritoneal dialysis	Hemodialysis	Total	p
	n=40	n=92	n=132	
Means of transport, n (%)				

Table 2. Out-of-pocket expenditure of the population on peritoneal dialysis and hemodialysis

Variable	Peritoneal dialysis	Hemodialysis	Total	p
	n=40	n=92	n=132	
Walking	1 (2.5)	1 (1.1)	2 (1.5)	0.058
Bus	4 (10)	3 (3.3)	7 (5.3)	
Transmilenio	5 (12.5)	9 (9.8)	14 (10.6)	
Taxi cab	7 (17.5)	12 (13)	19 (14.4)	
Private car	16 (40)	9 (9.8)	25 (18.9)	
Insurance/ state service	2 (5)	53 (57.6)	55 (41.7)	
Digital platform*	5 (12.5)	4 (4.3)	9 (6.8)	
Motorcycle	0 (0)	1 (1.1)	1 (0.8)	
Distance (km), median (IQR)	16.2 (6.7-25.9)	12.6 (7.8-16.4)	12.9 (7.6-18.1)	0.18
Time in transport (min), median (IQR)	112.5 (58.7-133.5)	102.5 (60-120)	105 (60-120.8)	0.57
Transport expense (COP) , median (IQR)	30,000 (6,000-52,765)	20,000 (10,497-30,000)	20,595 (8,371-37,274)	0.21
Hired caregiver, n (%)	6 (15)	12 (13)	18 (13.6)	0.98
Therapy, n (%)	3 (7.5)	7 (7.6)	10 (7.6)	1
Private nurse, n (%)	2 (5)	5 (5.4)	7 (5.3)	0.17
Private doctor, n (%)	4 (10)	4 (4.3)	8 (6.1)	0.39
Parking, n (%)	15 (37.5)	17 (18.5)	32 (24.2)	0.03
Documents, n (%)	1 (2.5)	12 (13)	13 (9.8)	0.12
Copayments, n (%)	9 (22.5)	27 (29.3)	36 (27.3)	0.54
Medication, n (%)	20 (50)	35 (38)	55 (41.7)	0.27
Nutrirional suplements, n (%)	11 (27.5)	19 (20.7)	30 (22.7)	0.52
Others, n (%)	23 (57.5)	25 (27.2)	48 (36.4)	0.0017
Our-of-pocket in MW, median(IQR)	0.24 (0.14-0.7)	0.43 (0.23-0.74)	0.41 (0.2-0.73)	0.06

Table 2. Out-of-pocket expenditure of the population on peritoneal dialysis and hemodialysis

Variable	Peritoneal dialysis	Hemodialysis	Total	p
	n=40	n=92	n=132	
Out-of-pocket expenditure in USD, median (IQR)	65.8 (39.4-189.3)	118.7 (63.7- 202)	112.3 (55.2-200)	0.06
IQR: Interquartile range; *Digital platforms: Uber, Didi, Cabify and others; MW: Current legal monthly minimum wages.				

Source: The authors.

Indirect costs

Indirect costs are presented in table 3. Patient disability time was documented as a median of 96 hours per month (IQR 50.6-136) for HD, while for PD it was 24 hours per month (IQR 13.3-130), with statistically significant differences after adjustment using multivariate logistic regression (p =0.002). There was no difference in caregiver productivity loss time (p = 0.46) or the corresponding indirect cost (p = 0.6). In the multivariate analysis, indirect costs were higher in HD, with 1.64 MW and USD 447.2 (IQR 201.3-766.2), compared to PD, with 0.56 MW and USD 153.3 (IQR 46.8-511.1) (p = 0.0002). The difference in indirect cost was adjusted using a gamma log-link regression model, which considered economic and statistical variables such as age, sex, education, income, and comorbidities.

Table 3. Indirect costs of the population in peritoneal dialysis and hemodialysis

Variable	Peritoneal dialysis n=40	Hemodialysis n=92	Total n=132	p
	Median (IQR)	Median (IQR)	Median (IQR)	
Patient's productivity time loss* Median(IQR)	24 (13.3-130)	96 (50.6-136)	96 (40-136)	0.0001
Caregiver's productivity time loss* Median(IQR)	0 (0-33)	0 (0-55)	0 (0-48)	0.46

Table 3. Indirect costs of the population in peritoneal dialysis and hemodialysis

Variable	Peritoneal dialysis n=40	Hemodialysis n=92	Total n=132	p
	Median (IQR)	Median (IQR)	Median (IQR)	
Patient's indirect cost in MW. Median(IQR)	0.21 (0.1-1.64)	1.12 (0.65-2.25)	0.96 (0.5-1.87)	0.0001
Patient's indirect cost in USD. Median(IQR)	57.4 (29.8-447.2)	306.6 (178-613.3)	264 (134.1-511.1)	0.0001
Total indirect costs in MW. Median(IQR)	0.56 (0.17-1.8)	1.64 (0.77-2.81)	1.47 (0.56-2.38)	0.0002
Total indirect costs in USD. Median(IQR)	153.3 (46.85-511.1)	447.2 (210.3-766.6)	401.9 (153.3-650.6)	0.0002
IQR: Interquartile range; *Patient's and caregiver's hours of productivity loss per month; MW: Current legal monthly minimum wages; USD: United States dollars.				

Source: The authors.

Discussion

Our study documented higher out-of-pocket expenses for ESRD patients on dialysis than the average previously reported [18]. Surprisingly, one-third of the surveyed patients reported catastrophic out-of-pocket expenses. In India, this issue has been documented in 9 out of 10 HD patients [19]. A study conducted in Taiwan showed higher out-of-pocket expenses for HD patients compared to PD patients [6]. However, our study's power should be increased to rule out these differences. Countries like Argentina [20], Uruguay, Ecuador [21], and Chile [22] have effectively eliminated direct OOP payments for dialysis, integrating ESRD care into their universal health coverage frameworks. Middle-income countries such as Brazil and Colombia also cover dialysis broadly, resulting in low official OOP costs (with remaining burdens mainly from travel and ancillary needs). In contrast, countries with historically weaker health systems—e.g. Bolivia (pre-2019) and parts of Peru—have seen many patients paying large sums or being unable to afford therapy [23, 24]. Overall, the last decade shows a trend toward expanded dialysis coverage in South America, reducing formal OOP requirements for patients. Bolivia's 2019 reform and Ecuador's earlier policy are examples of governments

recognizing dialysis as catastrophic care that should be publicly funded. Insurance schemes in Colombia and Chile have also strengthened financial protection for CKD patients. This has generally lowered direct out-of-pocket expenses as a percentage of total dialysis cost across the region. For instance, globally, the median patient share of dialysis cost is around 6.5 % [10, 25].

Beyond direct payments, CKD patients on dialysis often experience steep indirect costs. These stem from lost earnings, reduced work capacity, time spent by patients and family in caregiving, and lost productivity for society. Indirect cost was higher in HD patients compared with PD patients with statistical significance. This is due to the HD group's higher number of monthly hours of work disability, and the monetization of these hours is significantly higher. This aligns with the reported higher level of active employment in the PD patient group, which is critically related to the fixed service provision schedules for HD sessions and travel, consistent with previous findings [6]. HD's thrice-weekly clinic visits and recovery time disrupt normal life more than PD, which is often done at home (usually daily exchanges or automated overnight dialysis). PD can be better tailored around work schedules and avoids travel time, enabling higher patient productivity [26, 27]. A stark disparity exists between well-resourced health systems and poorer ones. Patients in high-income or upper-middle-income South American countries (Chile, Uruguay, Argentina, and parts of Brazil) are financially shielded from dialysis costs and generally have access to treatment. In contrast, in lower-income settings or those in crisis (Bolivia historically and Venezuela currently), dialysis access and affordability remain problematic. For instance, Latin American nephrologists lament that in some low-resource areas, "most people cannot afford dialysis… <10 % of patients receive KRT" due to cost and system limitations [12].

These findings can serve as a foundation for further research into out-of-pocket expenses and potential strategies to reduce them, which are associated with poor adherence to the therapy [28]. The results on indirect costs are a valuable source for developing cost-effectiveness studies from a social perspective. We acknowledge the potential bias in memory recall, which was minimized by supplementing event reports with the clinical history. A larger sample of PD patients is needed to assess differences in out-of-pocket expenses compared to HD and to make comparisons within PD types. Given the existing literature, automated PD may have higher out-of-pocket expenses and lower indirect costs [29].

Conclusion

A catastrophic expenditure was reported by 28.2 % of the cohort. Indirect costs are higher in HD compared to PD. A larger sample size is required to identify differences in out-of-pocket expenses and between types of PD.

Authors' contributions

Camilo A. González, Maria Camila Echeverria, Carolina Forero, Kateir Contreras, Darío Londoño, and Diana Vargas constructed the protocol. Camilo A. González, Maria Camila Echeverria, Ana María Arana, Carolina Forero, Kateir Contreras, Erica Yama, Diana Vargas, and Darío Londoño analyzed and interpreted the patient data and approved the final manuscript.

Ethical statement

The study was approved by the research and ethics committee of San Ignacio University Hospital with approval number 004/2023 in record number 1/2023 and by the Sanitas University Foundation with code CEIFUS 1583-23. This study complied with international regulations (particularly the Declaration of Helsinki and the ethical guidelines for biomedical research prepared by the Council of International Organizations of Medical Sciences, CIOMS). It was considered an investigation with low risk for the population of interest in accordance with the legal and ethical guidelines of Colombia (Resolutions 8430 of 1993 and 2378 of 2008 of the Ministry of Health of Colombia). Patients and a witness signed individual informed consent, a format approved by both research and ethics committees based on the same resolutions: 8430 of 1993 and 2378 of 2008 of the Ministry of Health of Colombia. The identification and location data was processed using codes to ensure anonymity.

Conflicts of interests

All the authors declared no competing interests.

Funding statement

None applicable.

Use of artificial intelligence (AI)

The authors declare that they did not use artificial intelligence in the preparation or writing of this article.

Availability of data and materials

The data that support the findings of this study are available from the principal investigator; however, restrictions apply to the availability of these data, which were used under license for the current study. Data are, however, available upon reasonable request via email to the coauthor: Camilo Gonzalez: camiloalbgonzalez@colsanitas.com

Acknowledgements

Thanks to the patients from both institutions for their time in conducting the interviews.

References

[1] Cockwell P, Fisher L-A. The global burden of chronic kidney disease. Lancet. 2020;395(10225):662–664. https://doi.org/10.1016/S0140-6736(19)32977-0 ↑See Page 3

[2] Cuenta de alto costo de Colombia. Situación de la enfermedad renal crónica, la hipertensión arterial y diabetes mellitus en Colombia 2019 [Internet]. Cuenta de alto costo de Colombia;2020 [cited 2021 Oct 11]. https://cuentadealtocosto.org/site/erc/ ↑See Page 3

[3] Sarmiento-Bejarano H, Ramírez-Ramírez C, Carrasquilla-Sotomayor M, Alvis-Zakzuk NJ, Alvis-Guzmán N. Economic burden of chonic kidney disease in Colombia, 2015-2016. Salud Uninorte. 2019;35(1):84–100. https://doi.org/10.14482/sun.35.1.616.6 ↑See Page 3

[4] Kaplan JM, Niu J, Ho V, Winkelmayer WC, Erickson KF. A Comparison of US medicare expenditures for hemodialysis and peritoneal dialysis. J Am Soc Nephrol. 2022;33(11):2059–2070. https://doi.org/10.1681/ASN.2022020221 ↑See Page 3

[5] Rosselli D, DeAntonio R, Calderón C. Análisis económico de diálisis peritoneal comparada con hemodiálisis en pacientes con enfermedad renal crónica, diabética o hipertensiva. MedUNAB. 2008;11(3):201–205. ↑See Page 3

[6] Tang C-H, Chen H-H, Wu M-J, Hsu B-G, Tsai J-C, Kuo C-C, *et al.* Out-of-pocket costs and productivity losses in haemodialysis and peritoneal dialysis from a patient interview survey in Taiwan. BMJ Open. 2019;9(3):e023062. https://doi.org/10.1136/bmjopen-2018-023062 ↑See Page 3, 11, 12

[7] Walker RC, Howard K, Tong A, Palmer SC, Marshall MR, Morton RL. The economic considerations of patients and caregivers in choice of dialysis modality. Hemodial Int. 2016;20(4):634–642. https://doi.org/10.1111/hdi.12424 ↑See Page 3

[8] Krol M, Brouwer W. How to estimate productivity costs in economic evaluations. Pharmacoeconomics. 2014;32(4):335–344. https://doi.org/10.1007/s40273-014-0132-3 ↑See Page 3

[9] Shahrook S, Mori R, Dovey SM, Koyanagi A, Shibuya K. Changes in out-of-pocket payments on utilisation of health care services. Cochrane Database Syst Rev. 2019;2019. https://doi.org/10.1002/14651858.CD003029.pub4 ↑See Page 3

[10] Wainstein M, Bello AK, Jha V, Harris DCH, Levin A, Gonzalez-Bedat MC, *et al.* International society of nephrology global kidney health atlas: structures, organization, and services for the management of kidney failure in Latin America. Kidney Int Suppl. 2021;11(2):e35–46. https://doi.org/10.1016/j.kisu.2021.01.005 ↑See Page 3, 12

[11] Calice-Silva V, Neyra JA, Ferreiro Fuentes A, Singer Wallbach Massai KK, Arruebo S, Bello AK, *et al.* Capacity for the management of kidney failure in the International Society of Nephrology Latin America region: report from the 2023 ISN Global Kidney Health Atlas (ISN-GKHA). Kidney Int Suppl. 2024;13(1):43–56. https://doi.org/10.1016/j.kisu.2024.01.001 ↑See Page 3

[12] Ulasi II, Awobusuyi O, Nayak S, Ramachandran R, Musso CG, Depine SA, *et al.* Chronic kidney disease burden in low-resource settings: Regional perspectives. Semin Nephrol. 2022;42(5):151336. https://doi.org/10.1016/j.semnephrol.2023.151336 ↑See Page 3, 12

[13] Harris PA, Taylor R, Minor BL, Elliott V, Fernandez M, O'Neal L, *et al.* The REDCap consortium: Building an international community of software platform partners. J Biomed Inform. 2019;95:103208. https://doi.org/10.1016/j.jbi.2019.103208 ↑See Page 4

[14] CEIC. Gasoline Retail Price [Internet]. CEIC;2023 [cited 2023 Jun 25]. https://www.ceicdata.com/en/colombia/gasoline-retail-price ↑See Page 4

[15] Sanabria M, Rodríguez MS, Sánchez KR, Astudillo K, Camargo D, Bunch A. Frecuencia y costos de hospitalización en una población de pacientes en diálisis en Colombia. Rev Fac Med. 2012;60(4):293–301. ↑See Page 4

[16] Valsa Jose J, Susan George J, Joseph R, Arun Thomas ET, Philip John G. Out-of-pocket expenditures, catastrophic household finances, and quality of life among hemodialysis patients in Kerala, India. Hemodial Int. 2022;26(4):569–574. https://doi.org/10.1111/hdi.13037 ↑See Page 4

[17] Wong CKH, Chen J, Fung SKS, Mok MMY, Cheng YL, Kong I, *et al.* Direct and indirect costs of end-stage renal disease patients in the first and second years after initiation of noc-

turnal home haemodialysis, hospital haemodialysis and peritoneal dialysis. Nephrol Dial Transplant. 2019;34(9):1565–1576. https://doi.org/10.1093/ndt/gfy395 ↑See Page 5

[18] OECDiLibrary. Health at a Glance 2021: OECD Indicators [Internet]. OECDiLibrary;2021 [cited 2023 Jun 2]. https://www.oecd.org/en/publications/2021/11/health-at-a-glance-2021_cc38aa56.html ↑See Page 11

[19] de Vries EF, Los J, de Wit GA, Hakkaart - van Roijen L. Patient, family and productivity costs of end-stage renal disease in the Netherlands; exposing non-healthcare related costs. BMC Nephrol. 2021;22(1):341. https://doi.org/10.1186/s12882-021-02548-y ↑See Page 11

[20] Orias M, Rosa Diez GJ. Global dialysis perspective: Argentina. Kidney360. 2020;1(7):676–679. https://doi.org/10.34067/KID.0001222019 ↑See Page 11

[21] Santacruz Mancheno J, Santacruz AC. Global Dialysis Perspectives: Ecuador. Kidney360. 2022;3(12). https://doi.org/10.34067/KID.0003762022 ↑See Page 11

[22] Bitran R. Explicit health guarantees for Chileans: The AUGE benefits package. UNICO Studies Series. 2013;(21). https://doi.org/10.1596/13281 ↑See Page 11

[23] Saldarriaga EM, Bravo-Zúñiga J, Hurtado-Roca Y, Suarez V. Cost-effectiveness analysis of a strategy to delay progression to dialysis and death among chronic kidney disease patients in Lima, Peru. Cost Eff Resour Alloc. 2021;19(1):70. https://doi.org/10.1186/s12962-021-00317-0 ↑See Page 11

[24] Arellan-Bravo L, Benito-Condor B, Gutiérrez-Aguado A. Direct cost analysis of renal replacement therapy in a Peruvian hospital. Acta Medica Peru. 2024;41(2):74–82. https://doi.org/10.35663/amp.2024.412.2845 ↑See Page 11

[25] van der Tol A, Lameire N, Morton RL, Van Biesen W, Vanholder R. An international analysis of dialysis services reimbursement. Clin J Am Soc Nephrol. 2019;14(1):84–93. https://doi.org/10.2215/CJN.08150718 ↑See Page 12

[26] Moalosi K, Sibanda M, Kurdi A, Godman B, Matlala M. Estimated indirect costs of haemodialysis versus peritoneal dialysis from a patients' perspective at an Academic Hospital in Pretoria, South Africa. BMC Health Serv Res. 2023;23(1):1119. https://doi.org/10.1186/s12913-023-10109-2 ↑See Page 12

[27] Julián-Mauro JC, Cuervo J, Rebollo P, Callejo D. Situación laboral y costes indirectos en pacientes con insuficiencia renal: Diferencias entre distintas modalidades de tratamien-

to renal sustitutivo. Nefrologia. 2013;33(3):333–341. https://dx.doi.org/10.3265/Nefrologia.pre2012.Dec.11767 ↑See Page 12

[28] Hirth RA, Greer SL, Albert JM, Young EW, Piette JD. Out-of-pocket spending and medication adherence among dialysis patients in twelve countries. Health Aff (Millwood). 2008;27(1):89–102. https://doi.org/10.1377/hlthaff.27.1.89 ↑See Page 12

[29] Tang C-H, Wu Y-T, Huang S-Y, Chen H-H, Wu M-J, Hsu B-G, *et al.* Economic costs of automated and continuous ambulatory peritoneal dialysis in Taiwan: a combined survey and retrospective cohort analysis. BMJ Open. 2017;7(3):e015067. https://doi.org/10.1136/bmjopen-2016-015067 ↑See Page 12